SPENT NUCLEAR FUEL

What is it?

Spent nuclear fuel, or SNF, is used-up fuel rods from nuclear reactors.

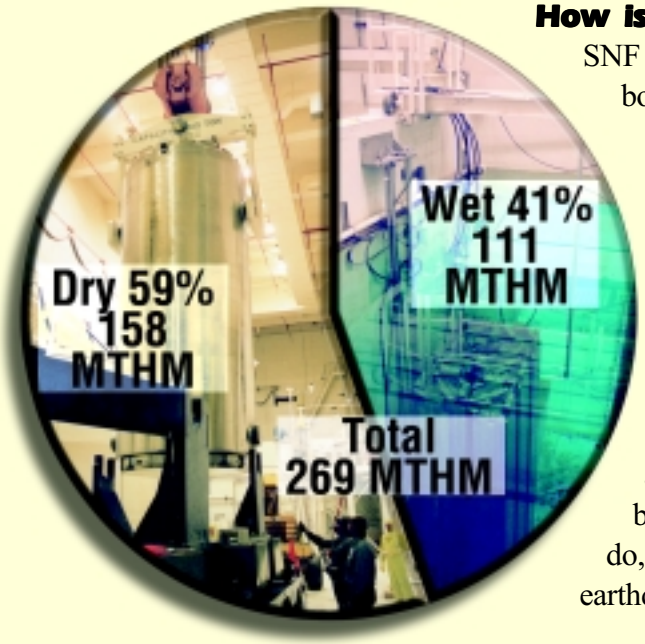
How is it created?

SNF is created when fuel rods containing uranium are placed in a nuclear reactor. Uranium atoms are split, producing energy. This reaction creates new elements like cesium and strontium, and transuranic elements like plutonium and americium. Over time, the fuel becomes less efficient. At some point, the fuel must be removed from the reactor and replaced with new fuel. It is "spent."

How much is there at INEEL?

SNF is measured by the volume of the uranium or plutonium it contains. This measurement does not include the volume of the cladding and hardware around the SNF. Volume is described in metric tons. A metric ton is 2,200 pounds—about the weight of a small car.

The most common heavy metal in SNF is uranium oxide. Three cubic feet of uranium oxide weigh about one metric ton. There are 269.1 metric tons of heavy metal of SNF at INEEL.



How is it stored at INEEL?

SNF is very "hot" when it is removed from a nuclear reactor, both "hot" as in hot to the touch (scientists call this thermal heat) and "hot" as in radioactive.

It will lose about 99% of its radioactivity within a year of being removed from the reactor. SNF is often stored under water for a time after it is removed from a reactor. The water helps cool and shield the SNF. If the SNF is a type that emits neutrons, water will absorb the neutrons.

The state wants SNF placed in dry storage as soon as possible. Dry storage containers can be above or below ground. They don't corrode like wet storage basins do, and they are safer in the event of a catastrophe like an earthquake or flood.

Where is it going to go?

We do not know where it is going to go in the long run. The Settlement Agreement requires DOE to remove SNF from Idaho, but leaves decisions about where it is to be taken up to DOE, saying ". . . a permanent repository for storage or disposal of spent fuel, *located outside of Idaho*. . ." Yucca Mountain, which may be the ultimate repository for spent nuclear fuel, isn't referred to in the agreement, as it was not yet built or licensed—just planned.

Spent nuclear fuel is one of the three waste streams covered by the Settlement Agreement. It's dealt with a little differently than the other two waste streams, because of the role spent fuel plays in enforcing DOE's and the Navy's obligations under the Agreement.

DOE and the Navy proposed to continue spent fuel shipments to the INEEL, but the State negotiated limits on the number of incoming shipments. DOE and the Navy must also meet certain obligation to continue to ship spent nuclear fuel to the INEEL. If DOE or the Navy doesn't meet its respective obligations, then the state can close its borders to further shipments of spent nuclear fuel.

The Settlement Agreement's spent fuel provisions are also unique because certain types of spent fuel are specifically excluded from the types of waste allowed to come to the INEEL.

Recent SNF management activities at the INEEL have focused on steps outlined in the Settlement Agreement to prepare it for shipment to a permanent repository. Argonne National Laboratory West, which is located within the INEEL site but run by the University of Chicago, and the Naval Reactors Facility have also made significant advances in SNF management.

Problem basins are emptied

Spent nuclear fuel wet storage basins in INTEC's building 603, built in the 50's, didn't meet current earthquake safety standards, did not have the stainless steel lining newer basins have, and didn't have a leak detection system. INEEL was required to empty the basins and close them under a court order issued as a result of a lawsuit filed by the state of Idaho against DOE, *DOE v. Andrus.*

The state alleged that DOE had not followed appropriate procedures for environmental decision-making. Several court orders were issued as the lawsuit made its way through the legal system, eventually leading to a more comprehensive agreement, the 1995 Settlement Agreement. DOE had to remove all spent nuclear fuel from the 603 basins by Dec. 31, 2000. The last basin was emptied eight months before the deadline, on April 28.

INEEL is now evaluating options for decommissioning the storage basins and the canals that connect them, as well as dealing with the 1.5 million gallons of water they hold. A decision is expected in Spring 2001.

Three Mile Island rubble

On March 28, 1979, a small valve at the Three Mile Island nuclear power plant in Pennsylvania failed to close, causing cooling water to drain from the nuclear core. The overheated core reached 4,300 degrees Fahrenheit—dangerously close to meltdown. This extreme temperature resulted in significant damage to reactor fuel and core structural materials.

To study the causes and effects of the accident, the core rubble was sent to INEEL for examination, study, and storage. The first shipment arrived in 1986 and the last in 1990. The Settlement Agreement specifically addressed the TMI waste, requiring DOE to move it to a new dry storage facility by June 2001.

Moving the waste is a complex task, requiring highway closures and a specially constructed shipping cask. Significant operational problems cause concern that DOE may not meet the deadline.

DOE will store TMI waste in the new dry storage facility, which is licensed by the Nuclear Regulatory commission, until it can be sent to a repository.

Naval dry storage facility

Spent fuel from the Navy's nuclear-powered submarines, aircraft carriers, and research reactors comes to the INEEL for examination at the Naval Reactors Facility (NRF). This work helps the Navy improve ship reactor operations and reactor design. Naval spent fuel is currently examined and stored in a pool at NRF. Some of the fuel is transferred to other pool storage at INTEC Building 666.

In the past year, NRF received spent fuel from the USS Nimitz, an active aircraft carrier that has been deployed around the world. Other spent fuel came from ships that are ready for decommissioning.

As part of the federal government's commitment to move fuel from wet storage to dry storage, NRF is constructing a Dry Fuel Storage Facility. This building will house all naval spent fuel in a dry condition until it can be sent to a repository or an out-of-state storage facility. Like other fuel at INEEL, naval spent fuel must leave Idaho by 2035 under the Settlement Agreement.

NRF is also building a Dry Cell Facility to reduce handling spent fuel in a wet pool. In this facility, NRF can disassemble spent fuel and load it into dry storage containers.

NRF is completing construction of a facility to store spent fuel "dry." Naval spent fuel will be moved here from pools at NRF and INTEC to await shipment out of Idaho. Other construction at NRF will allow the Nuclear Navy to handle spent fuel in a "dry" condition.

Argonne demonstrates advanced treatment method

Argonne National Laboratory–West has developed and proven important spent nuclear fuel management technologies. Argonne is a national research laboratory located within the INEEL and run by the University of Chicago for DOE.

The metallic fuel from a sodium-cooled reactor, known as sodium-bonded fuel, must be treated and stabilized before it can be disposed of safely. This is because the fuel becomes "soaked" with sodium, similar to how a sponge becomes soaked with water. Sodium has many industrial uses and offers many advantages in the operation of a nuclear reactor, but it is chemically reactive and can burn or explode if exposed to air or water.

DOE has about 60 metric tons of sodium-bonded fuel, nearly all of it in Idaho. Argonne operated a sodium-cooled reactor, EBR-II, from 1961 to 1994, and about 25 metric tons of spent fuel remain from EBR-II operations. Another 34 metric tons came to INEEL in the early 1970s from the Fermi reactor in Michigan.

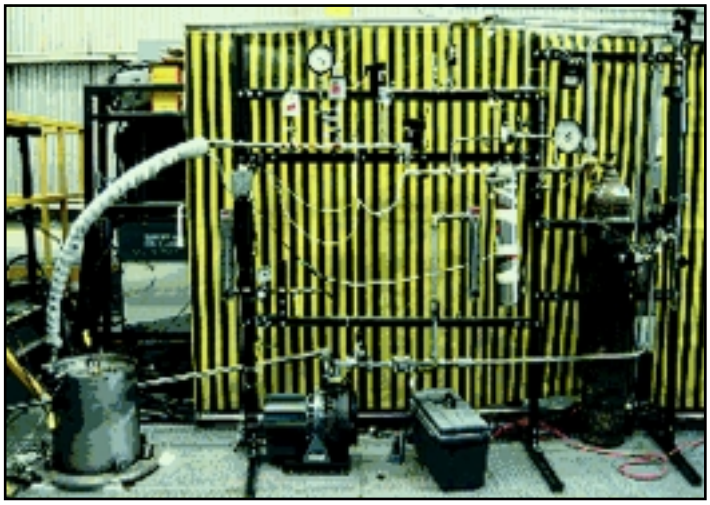
Argonne's new process, known as Electrometallurgical Treatment (EMT), stabilizes the sodium-bonded spent fuel and makes it safe for disposal. DOE has decided to treat the EBR-II fuel with this method over a 10-year period.

EMT treats the spent fuel by dissolving chopped pieces in a molten salt bath, then passing an electrical current through the liquid. The current causes the unused uranium remaining in the fuel to attach itself to a stainless steel rod. This uranium is removed, and mixed with depleted uranium to lower its enrichment. The low-enriched uranium will be set aside to await a DOE decision as to its disposition.

With the uranium removed, the salt bath contains fission products, highly radioactive elements left over from nuclear fission, and transuranic elements. The salt-based solution is mixed with glass and other materials and heated. This creates a ceramic form impervious to air and water, thus isolating the nuclear materials from the environment. The sodium reacts with the molten salt to form sodium chloride, or common table salt.

The ceramic waste is intended to be disposed of in an underground facility outside of Idaho in accordance with the Settlement Agreement. In the meantime, it will be kept at Argonne.

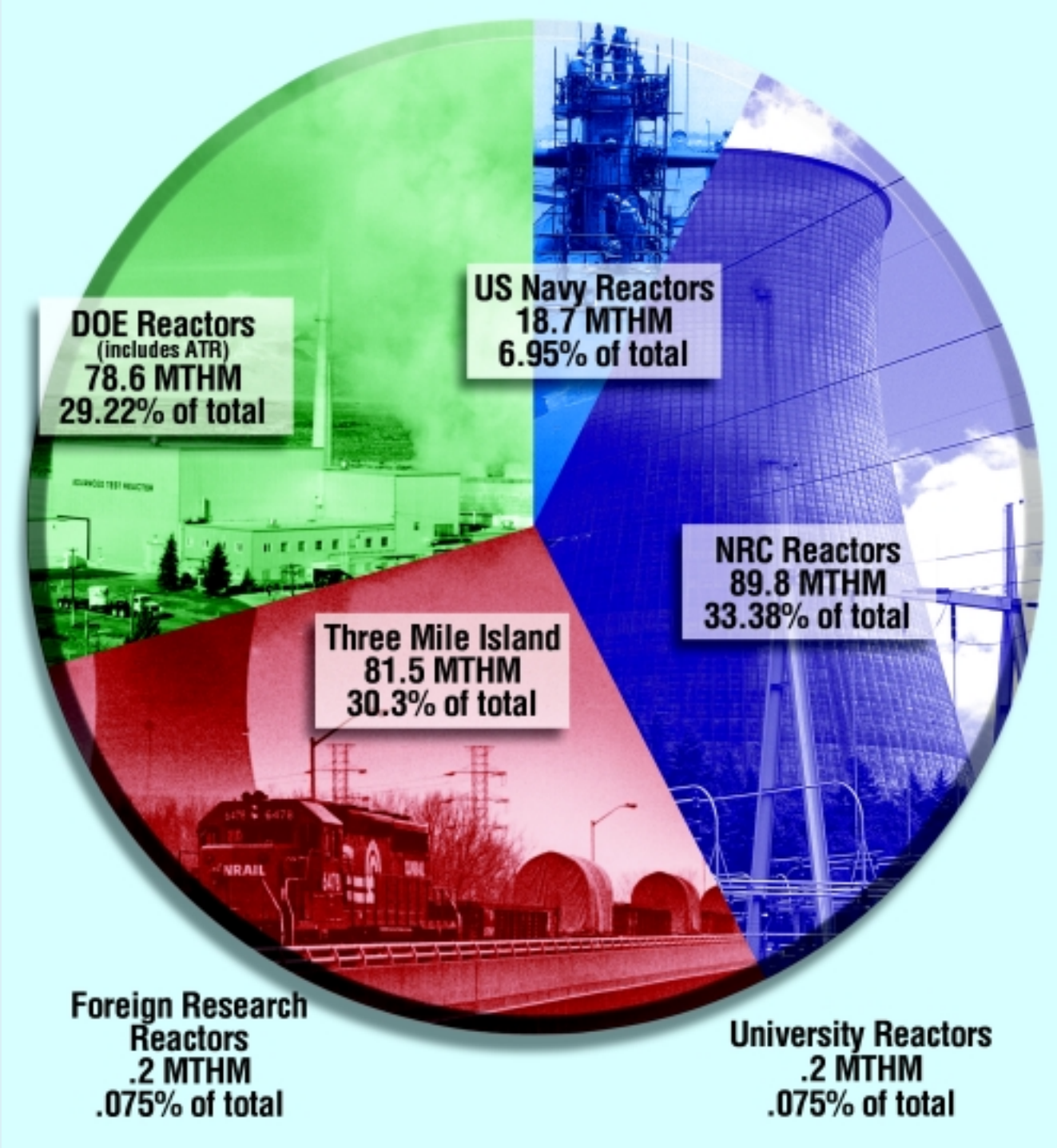
Some people oppose EMT, believing the technology can be modified to extract plutonium suitable for nuclear weapons use. However, EMT is based on electrochemical principles that cannot extract plutonium pure enough for this purpose.



Argonne is helping former Soviet Union republics address their Cold War legacy. A spent fuel drying station for long-term fuel storage developed at Argonne is now being used in Kazakhstan , a republic of the former Soviet Union.

Where did INEEL's spent nuclear fuel come from?

Spent nuclear fuel at the INEEL comes from many sources. Unlike the volume of high-level or transuranic waste at INEEL, which remains stable, the inventory of spent nuclear fuel increases each year. This will continue until a permanent repository opens for spent fuel.



Recent shipments of spent nuclear fuel to INEEL:

The Nuclear Navy sent 20 shipments of spent nuclear fuel to the INEEL in calendar year 1999, 2.1 metric tons of heavy metal. Sixteen containers of spent nuclear fuel (1.4 metric tons of heavy metal) were shipped in seven trains in 2000. One shipment of returned "Atoms for Peace" or so-called "Foreign Fuel" arrived at INEEL on July 31, 2000 from Great Britain.